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**United States Patent** [19]

Shehada et al.

[11] **Patent Number:** 6,124,597[45] **Date of Patent:** Sep. 26, 2000[54] **METHOD AND DEVICES FOR LASER INDUCED FLUORESCENCE ATTENUATION SPECTROSCOPY**[75] Inventors: **Ramez E. N. Shehada**, Los Angeles;  
**Vasilis Z. Marmarelis**, Irvine; **Warren S. Grundfest**, Los Angeles, all of Calif.[73] Assignee: **Cedars-Sinai Medical Center**, Los Angeles, Calif.[21] Appl. No.: **08/889,017**[22] Filed: **Jul. 7, 1997**[51] **Int. Cl.**<sup>7</sup> ..... **G01N 21/64**[52] **U.S. Cl.** ..... **250/461.2; 250/458.1; 600/321; 600/320; 600/323; 356/342**[58] **Field of Search** ..... **250/461.2, 458.1; 600/321, 320, 323; 356/342**[56] **References Cited****U.S. PATENT DOCUMENTS**

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[57]

**ABSTRACT**

The Laser Induced Fluorescence Attenuation Spectroscopy (LIFAS) method and apparatus preferably include a source adapted to emit radiation that is directed at a sample volume in a sample to produce return light from the sample, such return light including modulated return light resulting from modulation by the sample, a first sensor, displaced by a first distance from the sample volume for monitoring the return light and generating a first signal indicative of the intensity of return light, a second sensor, displaced by a second distance from the sample volume, for monitoring the return light and generating a second signal indicative of the intensity of return light, and a processor associated with the first sensor and the second sensor and adapted to process the first and second signals so as to determine the modulation of the sample. The methods and devices of the inventions are particularly well-suited for determining the wavelength-dependent attenuation of a sample and using the attenuation to restore the intrinsic laser induced fluorescence of the sample. In turn, the attenuation and intrinsic laser induced fluorescence can be used to determine a characteristic of interest, such as the ischemic or hypoxic condition of biological tissue.

**54 Claims, 17 Drawing Sheets**